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Till

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(54) **AIR DEFLECTORS FOR HEAT MANAGEMENT IN A LIGHTING MODULE**

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H05K 7/20 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***F21V 29/2293*** (2013.01); ***B01J 19/123*** (2013.01); ***F21V 19/002*** (2013.01); ***H05K 7/20145*** (2013.01); *F21Y 2105/001* (2013.01); *Y10T 29/49826* (2015.01)

(58) **Field of Classification Search**
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USPC ..... 362/249.02, 373, 294; 250/504 R
See application file for complete search history.

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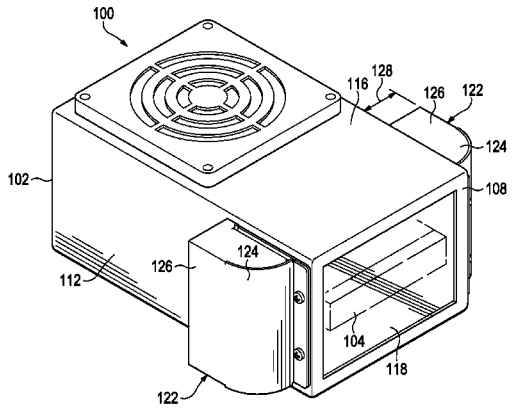
(57) **ABSTRACT**

A lighting module has an array of light-emitting elements that is electrically coupled to a heat sink and a housing having a heat exit. The array of light-emitting elements is positioned in the housing and the heat sink is positioned to dissipate heat generated within the housing so that the heat is expelled through the heat exit. A deflector is secured to the housing and is positioned to extend over some portion of the heat exit. The deflector guides heat away from the housing in a direction. In some configurations, the deflector guides heat away from the housing in a direction that is opposite the direction in which the array of light-emitting elements emit light. Also, some lighting modules have multiple heat exits and may have multiple deflectors extending over a portion of the respective heat exits.

18 Claims, 2 Drawing Sheets



(51) **Int. Cl.**

B01J 19/12	(2006.01)
F21V 19/00	(2006.01)
F21Y 105/00	(2006.01)

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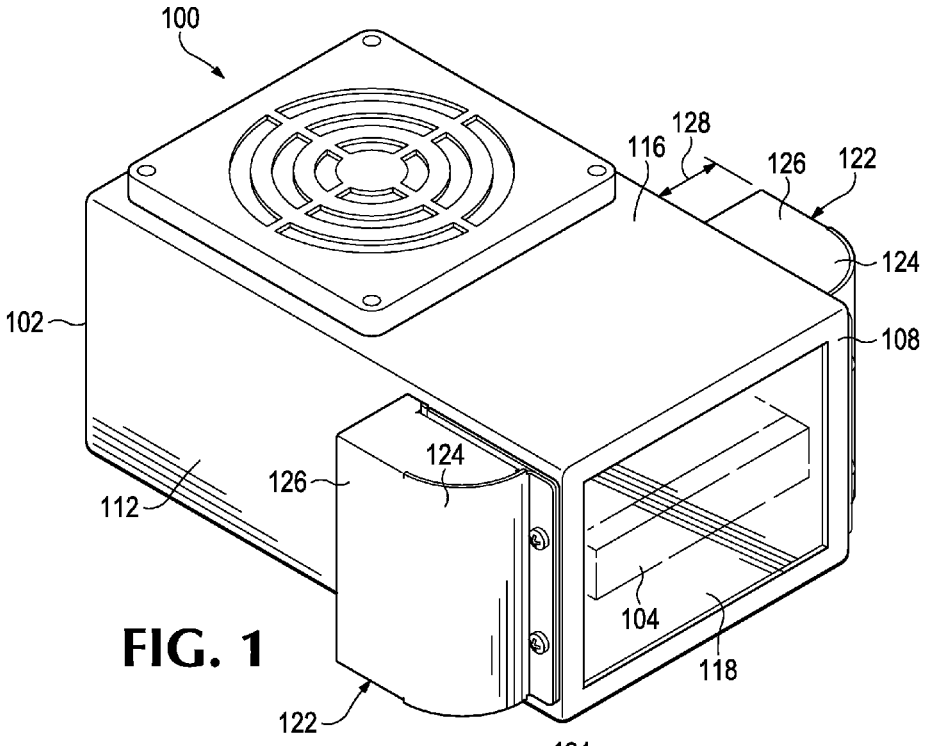
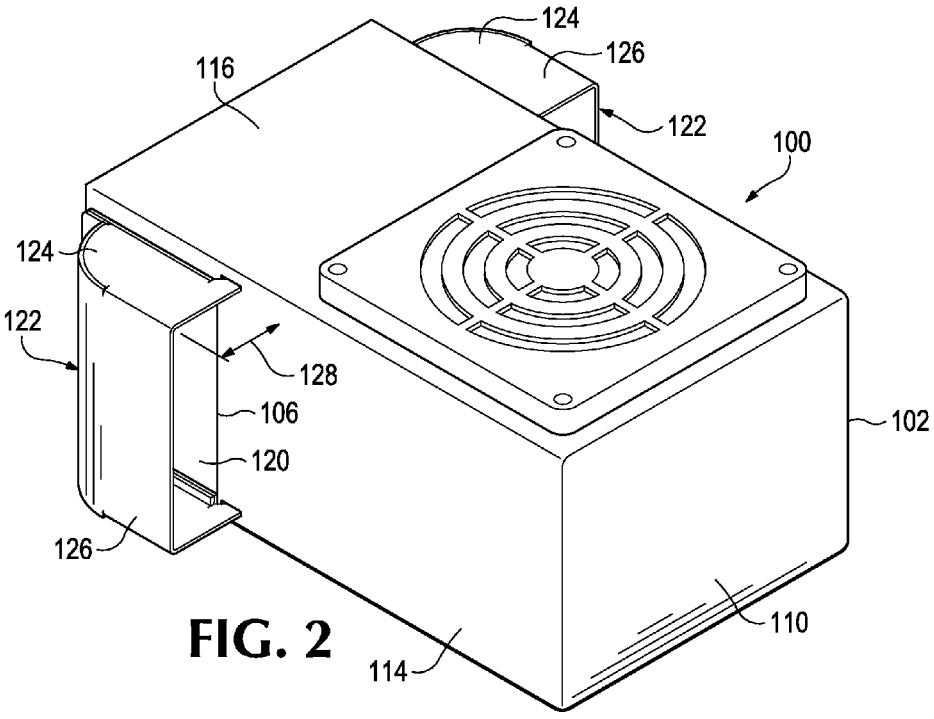

100
128
116
126
122
124
102
108
124
126
112
104
118
122

FIG. 1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126
116
122
100
124
122
128
106
120
102
126
110
114

FIG. 2

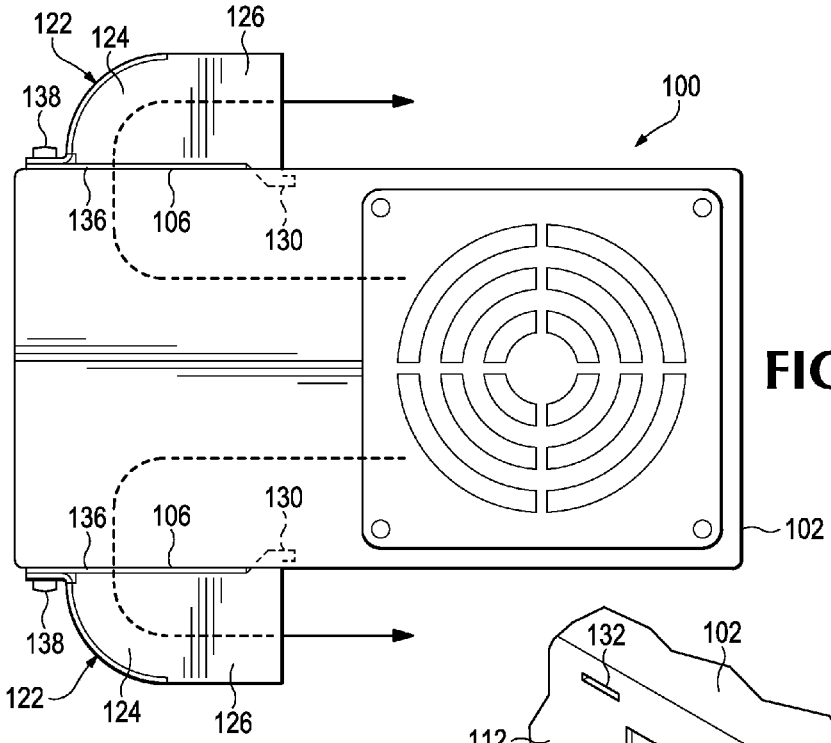
122
124
126
138
100
136
106
130
102
136
106
130
138
122
124
126

FIG. 3

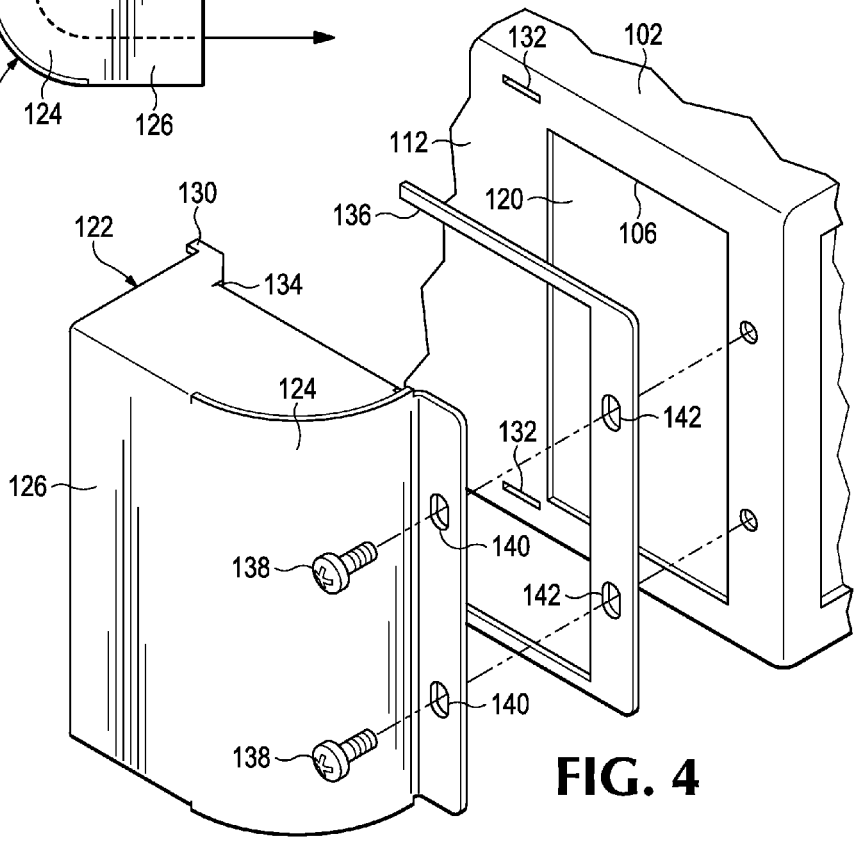
132
102
112
120
106
136
130
122
134
124
142
132
126
138
140
142
140
138

FIG. 4

AIR DEFLECTORS FOR HEAT MANAGEMENT IN A LIGHTING MODULE

CROSS REFERENCE TO RELATED APPLICATIONS

The present application is a continuation of U.S. patent application Ser. No. 13/408,973, entitled "AIR DEFLECTORS FOR HEAT MANAGEMENT IN A LIGHTING MODULE," and filed on Feb. 29, 2012, the entire contents of which are hereby incorporated by reference for all purposes.

BACKGROUND

Solid-state light emitters, such as light emitting diodes (LEDs) and laser diodes, have several advantages over using more traditional arc lamps during curing processes, such as ultraviolet (UV) curing processes. Solid-state light emitters generally use less power, generate less heat, produce a higher quality cure, and have higher reliability than traditional arc lamps. Some modifications increase the effectiveness and efficiency of the solid-state light emitters even further.

While solid-state light emitters emit less heat than their arc lamp counterparts, the temperatures emitted from the solid-state light emitters are still very high and can cause overheating of the solid-state light emitters during use and damage to the components of the solid-state light emitters over time. Overheating and damage to the components of the solid-state light emitters causes significant amounts of downtime for repair and loss of revenue.

Some solid-state light emitters try to incorporate cooling systems to remove some of the heat that is generated when the solid-state light emitter emits light. Oftentimes, these cooling systems include one or more heat sinks that help remove heat generated by the solid-state light emitters from the housing through openings or other heat exits in the housing, which results in air being expelled from the housing. These openings or heat exits in the housing are generally located near the medium on which the curing process occurs and can cause air to be expelled onto the medium, which disturbs or damages the curing process and decreases its accuracy. This results in the curing process needing to be repeated, which increases manufacturing costs and decreases quality and efficiency.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** shows a front perspective view of a lighting module having deflectors.

FIG. **2** shows a back perspective view of the lighting module with the deflectors shown in FIG. **1**.

FIG. **3** shows a top plan view of the air flow pathway that exits the lighting module having the deflectors that is illustrated in FIG. **1**.

FIG. **4** shows a partial exploded view of a deflector and the portion of the lighting module to which it is secured.

DETAILED DESCRIPTION OF THE EMBODIMENTS

FIGS. **1** and **2** show a lighting module **100** having a housing **102**, an array of light-emitting elements **104**, and a pair of heat exits **106**. The housing **102** is a rectangular, box-shaped structure in this example, although it can be any other suitable size and shape in other configurations. The housing **102** is a protective structure to house the array of light-emitting elements **104** and may include any suitable protective materials. The housing **102** in FIGS. **1** and **2** has a front surface **108**, a back surface **110**, two opposing side surfaces **112**, **114**, a top surface **116**, and a bottom surface (not shown). The front surface **108** includes a window **118** through which the array of light-emitting elements **104** emits light. The window **118** may be positioned on another suitable surface of the housing **102** in other configurations.

The window **118** of the lighting module **100** is positioned such that the array of light-emitting elements **104** emit light toward a medium with some type of light-curable material. For example, the lighting module **100** is positioned vertically and a substrate, such as paper or plastic, is positioned below the lighting module **100**, such that the front surface **108** of the lighting module **100** having the window **118** through which the light is emitted faces the substrate. The light-curable material is positioned on the substrate so that the light cures the material when light is emitted through the window **118**. The lighting module **100** is movable with respect to the medium in some configurations and may be adjustable in any suitable direction to achieve the necessary cure of the light-curing material to the medium. The array of light-emitting elements **104** may include light-emitting diodes (LEDs). These LEDs may emit light in a range of wavelengths. For example, the LEDs may emit ultraviolet light in the range of wavelengths between 10-400 nanometers.

During the curing process, the array of light-emitting elements **104** generates a substantial amount of heat when it emits light that can damage the lighting module **100**. Various heat management systems have been developed to help control the heat generated during this process, such as including one or more heat sinks **120** in the lighting module **100**. The heat sink(s) **120** included in the lighting module **100** are often positioned to dissipate the heat generated within the housing **102** so that the heat can be expelled through a heat exit **106** or other type of opening in the housing **102** of the lighting module **100**. In some examples, the heat dissipated by the heat sink(s) is expelled through the heat exits by a fan or other expulsion device. In other configurations, the heat is expelled through the heat exits in a passive manner without the use of a fan or any other type of expulsion device. Reference to the expulsion of heat from the housing **102** of the lighting module **100** includes both the active expulsion of the heat by an expulsion device, such as a fan, and the passive expulsion of heat that does not require any type of assistive device to cause the heat to exit the housing **102**. Example heat exits **106** and an example heat sink **120** are shown in FIGS. **1** and **2**.

The heat sink(s) **120** dissipate warm or hot air generated within the housing **102** that then exits the housing **102** through the heat exits **106** or openings positioned on the opposing side surfaces **112**, **114** of the housing **102**, as shown in FIGS. **1** and **2**. In some examples, the heat sink(s) **120** are spaced apart from or otherwise considered a discrete element from the heat exits **106**. In other examples, the heat sinks **120** are integrally formed with the heat exits **106**. FIGS. **1** and **2** show a portion of a heat sink that is positioned within the openings of the heat exits **106**. In this configuration, warm or hot air is expelled through the heat exits **106**. Without the deflectors **122** shown in FIGS. **1** and **2**, this air is expelled in various directions from the housing **102**, including toward the front surface **108** and the window **118** of the housing **102** and thus toward the medium where the curing occurs. When air is allowed to be expelled in the direction of the medium where the curing occurs, it often disrupts the curing process. The deflectors **122** shown in FIGS. **1** and **2** guide the heat that generates the warm or hot air away from the housing **102** in a direction away from the medium upon which the curing occurs. In these examples, the deflectors **122** guide the heat away from the housing **102** in a direction away from the

window **118** through which the light is emitted because the medium is positioned adjacent or otherwise near the window **118**.

The deflectors **122** in FIGS. **1** and **2** guide the air away from the housing **102** of the lighting module **100** in a direction that is approximately 180° away from the window **118**, essentially in a direction exactly opposite of the window **118**, as shown by the arrows in FIG. **3**. This configuration causes the least amount of air to disrupt the curing process because the air flow path directs the air in the opposite direction of the window **118** on the front surface **108** of the lighting module **100** and thus away from the medium upon which the curing process occurs. However, alternative examples the deflectors **122** guide the air in a direction that is at an angle that is at least 90° with respect to the window **118** and in other examples the deflectors guide the air in a direction that is at an angle that is at least 120° with respect to the window **118**.

The deflectors **122** are any suitable shape that guides the heat away from the housing **102** of the lighting module **100**. The deflectors **122** in FIGS. **1-4** have a curved portion **124** at one end that extends over a portion of the heat exit **106**. In other configurations, the curved portion **124** extends over the entire heat exit **106** or accounts for the entire deflector **122**. For example, the contour of the deflector **122** may be entirely curved (i.e., the curved portion may comprise the entire deflector), may have multiple different curved portions, or may be some combination of curved and linear portions. Again referring to FIGS. **1-3**, the deflectors **122** have a curved portion **124** and a linear portion **126**. The curved portion **124** and a portion of the linear portion **126** extend over the heat exit **106** in these examples. The linear portion **126** extends beyond the heat exit **106** on the side surface **112** of the lighting module **100**. The deflector **122** extends a distance **128** away from the side surface **112** of the lighting module **100** to permit heat and air to be guided away from the housing **102**. The radius of curvature of the curved portion **124** affects the angle at which the air or heat is guided away from the housing **102** of the lighting module **100**. As the radius of curvature of the curved portion **124** decreases the angle at which the heat or air is guided away from the housing **102** of the lighting module **100** increases with respect to the window **118** and the medium.

In FIGS. **1-3**, the lighting module **100** includes two heat exits **106** and two corresponding deflectors **122** that extend over their respective heat exits **106**. In this example, a deflector **122** is positioned to extend over every heat exit **106**. However, in alternative configurations, some heat exits do not have a corresponding deflector. The heat exits are positioned anywhere on the housing of the lighting module in any suitable arrangement and on any surface of the housing. The heat exits are arranged to most effectively help the heat sinks expel the heat and air from the housing when the array of light-emitting elements generate heat during use. In some examples, one heat sink **120** is positioned within the housing **102** to dissipate heat generated within the housing **102**, which is then expelled during use of the light-emitting elements **104**. The housing **102** may have two heat exits **106** positioned on either side surface **112**, **114** of the housing **102** to expel heat from the heat sink **120**, as shown in FIGS. **1-3**. In some examples, the heat exits **106** are a discrete element from the heat sink **120** and in other examples, the heat exit(s) **106** form a portion of the heat sink **120**. In other examples, multiple heat sinks are positioned in the housing and expel heat or air through one or more heat exits in any suitable manner. One or more deflectors may be positioned over anyone or more heat exits in these examples.

FIG. **4** shows a partial exploded view of a deflector **122** and the portion of the lighting module **100** to which it is secured. The deflector **122** is secured to the housing **102** with two different securing mechanisms in this example, although any suitable number and type(s) of securing mechanisms may be used in alternative configurations. The securing mechanism (s) may permanently attach the deflector to the housing of the lighting module, such as via cements, bonding, adhesives, and the like or the deflector may be removable from the housing such as with detachable mechanical connectors. The first securing mechanism includes two tabs **130** secured to or otherwise formed integrally with the deflector **122** and a complementary set of slots **132** into which the tabs **130** are fitted. The tabs **130** are located near the opening of the deflector **122** and on the surface of the deflector **122** that physically contacts the housing **102** when the deflector **122** is secured to the housing **102**. The tabs **130** define a notch **134** into which an edge of a spacer **136** fits. The spacer **136** is positioned between the deflector **122** and the housing **102** and extends around a portion of the perimeter of the heat exit **106**. Some spacers function as a type of gasket or sealer and may include various heat and/or moisture resistant materials. When the spacer functions as a type of gasket or sealer, it helps to prevent air that exits the lighting module **100** from escaping at the seam between the deflector **122** and the housing **102** and helps guide the air through the deflector **122** and away from the lighting module **100** in the intended direction. The second securing mechanism is a set of two screws **138** that extend through screw holes **140** in the deflector **122**, screw holes **142** in the spacer **136**, and into the housing **102**. Other configurations include any other suitable securing mechanism.

It will be appreciated that variations of the above-disclosed lighting modules and other features and functions, or alternatives thereof, may be desirably combined into many other different systems, methods, or applications. For example, methods of guiding air or heat away from a lighting module may use anyone or more of the above disclosed deflectors. Also various presently unforeseen or unanticipated alternatives, modifications, variations, or improvements therein may be subsequently made by those skilled in the art which also are intended to be encompassed by the following claims. Thus, although there has been described to this point a particular embodiment for a method and apparatus for lighting modules with deflectors, it is not intended that such specific references be considered as limitations upon the scope of this invention except in-so-far as set forth in the following claims.

What is claimed is:

1. A lighting module, comprising:

an array of light-emitting elements;

a heat sink, wherein at least a portion of the array of light-emitting elements is electrically coupled to the heat sink;

a housing having a first heat exit, wherein the array of light-emitting elements is positioned in the housing, and wherein the heat sink is positioned to dissipate heat generated within the housing so that the heat is expelled through the first heat exit, the housing being a rectangular, box-shaped structure; and

a first deflector secured to the housing and positioned to extend over at least a portion of the first heat exit, wherein the first deflector has a curved portion and an opening for guiding the heat away from the housing in at least one direction and is removable from the housing.

2. The lighting module of claim **1**, wherein the array of light-emitting elements includes light-emitting diodes.

3. The lighting module of claim **2**, wherein the light-emitting diodes emit ultraviolet light.

4. The lighting module of claim 1, wherein the housing further has a second heat exit positioned to dissipate heat generated within the housing so that at least a portion of the heat is expelled through the second heat exit, and wherein the second heat exit is spaced apart from the first heat exit.

5. The lighting module of claim 4, further comprising a second deflector positioned to extend over at least a portion of the second heat exit, wherein the second deflector guides heat away from the housing in at least one direction.

6. The lighting module of claim 1, wherein the housing includes a window through which the array of light-emitting elements emits light, and wherein the first deflector guides heat away from the housing in a direction away from the window.

7. The lighting module of claim 6, wherein the first deflector guides heat away from the housing at an angle of at least 90° with respect to the window.

8. The lighting module of claim 6, wherein the first deflector guides heat away from the housing at an angle of at least 120° with respect to the window.

9. The lighting module of claim 1, wherein at least a portion of the heat generated within the housing is generated by the array of light-emitting elements.

10. The lighting module of claim 1, wherein the angle at which the heat is guided away from the housing is at least partially dependent upon the shape of the curved portion.

11. A lighting module, comprising:

a housing defining a first side wall, a second, opposing side wall, and a first interconnecting wall connecting the first side wall and the second side wall, and further defining a first opening in the first side wall, the housing being a rectangular, box-shaped structure;

an array of light-emitting elements positioned in the housing;

a heat sink, wherein the array of light-emitting elements is electrically coupled to the heat sink, and wherein at least a portion of the heat sink is secured within the first opening of the first side wall of the housing; and

a first deflector positioned to extend over at least a portion of the first opening such that the first deflector guides heat dissipated from the heat sink away from the housing in at least one direction.

12. The lighting module of claim 11, wherein the lighting module further includes a window secured to the first interconnecting wall and through which the array of light-emitting elements emits light.

13. The lighting module of claim 12, wherein the first deflector guides heat away from the housing in a direction away from the window.

14. The lighting module of claim 13, wherein the direction away from the window is at least an angle of 90° with respect to the window.

15. The lighting module of claim 13, wherein the direction away from the window is at least an angle of 120° with respect to the window.

16. The lighting module of claim 11, wherein the second side wall further defines a second opening, wherein at least a portion of the heat sink is secured within the second opening.

17. The lighting module of claim 16, further comprising a second deflector positioned to extend over at least a portion of the second opening, wherein the second deflector guides heat away from the housing in at least one direction.

18. A lighting module, comprising:

an array of light-emitting elements;

a heat sink, wherein at least a portion of the array of light-emitting elements is electrically coupled to the heat sink;

a housing having a first heat exit, wherein the array of light-emitting elements is positioned in the housing, and wherein the heat sink is positioned to dissipate heat generated within the housing so that the heat is expelled through the first heat exit, the housing being a rectangular, box-shaped structure;

a first deflector secured to the housing and positioned to extend over at least a portion of the first heat exit, wherein the first deflector guides the heat away from the housing in at least one direction and is removable from the housing, the first deflector being a combination of curved and linear portions; and

a second deflector positioned to extend over at least a portion of a second heat exit oppositely positioned from the first deflector on an opposite wall of the box-shaped structure, wherein the second deflector guides heat away from the housing in at least one direction.

* * * * *